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oscillation of the tines. A laser is used for removing mass from the front surfaces of the tines in order to provide a symmetrical oscillation of the tines and thus a balanced condition. While this technique may result in a balanced fork, it is not useful in tuning fork rate sensors because it does not provide  
5 any adjustment of the quadrature output, and the quadrature offset would, in general, remain quite large.

It is in general an object of the invention to provide a new and improved tuning fork and method of manufacture.

Another object of the invention is to provide a tuning fork and method of the  
10 above character which overcome the limitations and disadvantages of the prior art.

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Another object of the invention is to provide a tuning fork and method of the above character in which quadrature error is reduced without disturbing tine mass symmetry.

15 These and other objects are achieved in accordance with the invention by providing a tuning fork and method in which a pair of elongated tines having front and rear surfaces are disposed symmetrically about an axis, and balancing masses on the front surface of one tine and on the rear surface of the other tine are trimmed to reduce quadrature error and also to maintain  
20 mass balance between the tines.

Figure 1 is a top plan view of one embodiment of a tuning fork incorporating the invention.

Figure 2 is an enlarged cross-sectional view taken along line 2 — 2 in Figure 1.

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In the event that the removal of the two mass elements does not produce exactly equal reductions in quadrature signal, the combination of the two mass elements being removed will still reduce quadrature error without disturbing tine mass symmetry. This is an important difference between the invention and the prior art.

The determination as to which mass elements to trim is dependent upon the polarity of the quadrature signal. For example, if the quadrature signal is of positive polarity, one might trim mass 26 on the top of tine 11 and mass 29 on the bottom of tine 12. If the polarity is negative, mass 27 would then be trimmed on the top of tine 12, and mass 28 would be trimmed on the bottom of tine 11.

The mass elements can be trimmed by any suitable means such as a laser. In one presently preferred embodiment, the tines are fabricated of a material such as crystalline quartz which is transparent to the laser beam, and all of the masses are trimmed from the same side of the fork. Thus, for example, the laser might be positioned on the front side of the fork, with the beam passing through the fork to trim elements 28, 29 on the back sides of the tines. Alternatively, if desired, the laser beam can be directed to the back sides of the tines by other means such as mirrors, or by turning the tuning fork over.

Instead of depositing masses on the tines and then removing portions of them to reduce quadrature signal, the same result can be obtained by the use of applied masses. In this case, masses are applied to opposite surfaces of the two tines to reduce quadrature error, and although the mass of the tines is increasing rather than decreasing, the symmetry of mass between the two tines is maintained.

In practical devices, it is important to adjust not only the quadrature offset in the mass trimming process, but also the resonant frequencies of both the

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phase of vibration. The balance of the fork is adjusted by removing mass from one of the tines until the vibration is zero, following which quadrature error can be reduced by removing mass from opposite sides of the two tines as described above.

- 5       The invention has a number of important features and advantages. It reduces quadrature error without disturbing the symmetry or balance in mass between the tines of a tuning fork, and it also permits the drive mode frequency and the pickup mode frequency to be adjusted independently of each other. It is readily automated for increased productivity and decreased cost.
- 10       It is apparent from the foregoing that a new and improved tuning fork and method have been provided. While only certain presently preferred embodiments have been described in detail, as will be apparent to those familiar with the art, certain changes and modifications can be made without departing from the scope of the invention as defined by the following claims.